WHAT IS CLAIMED IS:

1. An estimating apparatus for a secondary cell, comprising:

a current detecting section that detects a current (I) charged into and discharged from the secondary cell;

a voltage detecting section that detects a terminal voltage (V) across the secondary cell;

a parameter estimating section that integrally estimates all parameters (θ) at one time in at least one of the following equations (1) and (2) with the measured current (I) and terminal voltage (V) inputted into an adaptive digital filter using a cell model described in a corresponding one of the following equations (1) and (2) whose parameters are estimated;

an open-circuit voltage calculating section that calculates an open-circuit voltage (Vo) using the current (I), the terminal voltage (V), and the parameter estimated values (θ);

an input enabling power estimating section that estimates an input enabling power (P_{in}) of the secondary cell on the basis of the parameter estimated values (θ) and open-circuit voltage (Vo); and

an output enabling power estimating section that estimates an output enabling power (P_{out}) of the secondary cell on the basis of the parameter estimated values and the open-circuit voltage (Vo), the equation (1) being

$$V = \frac{B(s)}{A(s)} \bullet I + \frac{1}{C(s)} \bullet Vo \quad \ldots (1),$$ wherein

$A(s) = \sum_{k=0}^{n} a_k \bullet s^k$, $B(s) = \sum_{k=0}^{n} b_k \bullet s^k$, $C(s) = \sum_{k=0}^{n} c_k \bullet s^k$, s denotes a Laplace transform operator, A(s), B(s), and C(s) denote each poly-nominal of s (n denotes degrees), $a_1 \neq 0$, $b_1 \neq 0$, and $c_1 \neq 0$ and the equation (2) being $V = \frac{B(s)}{A(s)} \bullet I + \frac{1}{A(s)} \bullet Vo$ ... (2), wherein

$A(s) = \sum_{k=0}^{n} a_k \bullet s^k$ and $B(s) = \sum_{k=0}^{n} b_k \bullet s^k$.

2. An estimating apparatus for a secondary cell as claimed in claim 1, wherein the adaptive digital filter uses the cell model described in the equation (1) and the parameter estimating section integrally estimates all of the parameters (θ) in the equation (1) at one time and wherein, in a case where the terminal voltage of the secondary cell immediately before the secondary cell becomes a predetermined excessive charge is assumed to be a maximum enabling voltage (V_{max}) and the terminal voltage of the secondary cell immediately before the secondary cell becomes a predetermined excessive discharge is assumed to be a minimum enabling voltage (V_{min}), the input enabling power estimating section estimates the input enabling power (P_{in}) of the secondary cell on the basis of the parameter estimated values (θ), the open-circuit voltage (Vo), and the maximum enabling voltage (V_{max}) and the output enabling power estimating section estimates the output enabling power (P_{out}) of the secondary cell on the basis of the parameter estimated values (θ), the open-circuit voltage (Vo), and the minimum enabling voltage (V_{min}).

3. An estimating apparatus for a secondary cell as claimed in claim 2, wherein the input enabling power estimating section calculates Vo/C(s) from the parameter estimated values and the open-circuit voltage (Vo) and the input enabling power estimating section estimates the input enabling power (P_{in}) of the secondary cell on the basis of one of the open-circuit voltage (Vo) and the calculated (Vo/C(s)) whose value is nearer to the maximum enabling voltage (V_{max}), the parameter estimated values (θ), and the minimum enabling voltage (V_{min}).

4. An estimating apparatus for a secondary cell as claimed in claim 2, wherein the output enabling power estimating section calculates Vo/C(s) from the parameter estimated values (θ) and the open-circuit voltage (Vo) and the output enabling power estimating section estimates the output enabling power (P_{out}) of the secondary cell on the basis of one of the open-circuit voltage (Vo) and the calculated Vo/C(s) whose value is nearer to the minimum enabling voltage (V_{min}), the parameter estimated values (θ), and the maximum output enabling voltage (V_{max}).

5. An estimating apparatus for a secondary cell as claimed in claim 2, wherein the input enabling power estimating section calculates Vo/C(s) from the parameter estimated values (θ) and the open-circuit voltage (Vo) and estimates the input enabling power (P_{in}) of the secondary cell on the basis of one of the open-circuit voltage (Vo) and the calculated Vo/C(s) whose value is nearer to the maximum enabling

voltage (V_{max}), the parameter estimated values (θ), and the maximum enabling voltage (V_{max}) and wherein the output enabling power estimating section estimates the output enabling power (P_{out}) of the secondary cell on the basis of one of the open-circuit voltage (Vo) and the calculated Vo/C(s) whose value is nearer to the minimum enabling voltage (V_{min}).

6. An estimating apparatus for a secondary cell as claimed in claim 5, wherein the input enabling power estimating section estimates the input enabling power (P_{in}) using the following equation:

$$\left. \begin{aligned} P_{in} &= I_{in\_max} \bullet V_{max} \\ &= \frac{V_{max} - V_0}{e} \bullet V_{max} \end{aligned} \right]$$

, wherein I_{in_max} denotes a maximum input current to the secondary cell calculated from the following equation: $V = K \bullet I + V_0$, wherein e is substituted for K, V_{max} is substituted into V, I_{in_max} is substituted for I, and $V_0(k)$ is substituted for Vo, $V_0(k) = \Delta Vo(k) + V_{\_ini}$, wherein $V_0(k)$ is substituted for $\Delta Vo(k)$ and $V_{\_ini}$ denotes an initial value of the terminal voltage when no current from the secondary cell is caused to flow, and $e = K + h \bullet T_1 \fallingdotseq K$, wherein K denotes one of the parameter estimated values (θ) which corresponds to an internal resistance of the secondary cell, when the calculated open-circuit voltage $V_0(k)$ at a time point of k is equal to or higher than an apparent open-circuit voltage $V'_0(k)$ and estimates the input enabling power (P_{in}) using the following equation:

$$P_{in} = I_{in\_max} \bullet V_{max}$$

$$= \frac{V_{max} - V_o'}{e} \bullet V_{max}$$

$$= \frac{V_{max} - \frac{V_o}{b \bullet s + 1}}{e} \bullet V_{max}$$

,wherein b = $T_3 + T_1 \fallingdotseq T_3$ and T_1 and T_3 denotes time constants, when the calculated open-circuit voltage $V_0(k)$ at the time point of k is lower than the apparent open-circuit voltage $V'_0(k)$, wherein $V_0(k) = \Delta Vo(k) + V\__{ini}$, wherein $V_0(k) = \Delta Vo(k)$, when the calculated open-circuit voltage $V_0(k)$ at the time point of k is lower than an apparent open-circuit voltage $V'_0(k)$.

7. An estimating apparatus for a secondary cell as claimed in claim 6, wherein the output enabling power estimating section estimates the output enabling power (P_{out}) using the following equation:

$$P_{out} = | I_{out\_max} | \bullet V_{min}$$

$$= \frac{V_o - V_{min}}{e} \bullet V_{min}$$

,when the calculated open-circuit voltage Vo(k) at the time point of k is equal to or higher than the apparent open-circuit voltage Vo'(k) and

$$P_{out} = | I_{out\_max} | \bullet V_{min} = \frac{V_o' - V_{min}}{e} \bullet V_{min} = \frac{\frac{V_o}{b \bullet s + 1} - V_{min}}{e} \bullet V_{min}$$

, when the calculated open-circuit voltage ($V_0(k)$) at the time point of k is lower than the apparent open-circuit voltage ($V'_0(k)$) at the time point of k.

8. An estimating apparatus for a secondary cell as claimed in claim 7, wherein $\Delta V'_0 = \frac{1}{T_3 \bullet s + 1} \bullet \Delta V_0 \cong \frac{1}{b \bullet s + 1} \bullet \Delta V_0$ corresponds to Vo/C(s) and wherein $\Delta V_0 = \frac{(T_1 \bullet s + 1)}{G_2(s)} \bullet V_0 = a \bullet V_6 + b \bullet V_5 + V_4 - c \bullet I_6 - d \bullet I_5 - e \bullet I_4$, and wherein $a = T_1 \bullet T_3$, $b = T_1 + T_3$, $c = K \bullet T_2 - T_3$, $d = K \bullet (T_2 + T_3)$, $e = K + h \bullet T_1 \approx K$, $G_2(s)$ denotes a low pass filter, T_1, T_2, and T_3 denote each time constant, and

$$\begin{aligned} I_4 &= \frac{1}{G_2(s)} \bullet I & V_4 &= \frac{1}{G_2(s)} \bullet V \\ I_5 &= \frac{s}{G_2(s)} \bullet I & V_5 &= \frac{s}{G_2(s)} \bullet V & \frac{1}{G_2(s)} &= \frac{1}{p_2 \bullet s + 1} \bullet \frac{1}{T_1 \bullet s + 1} \\ I_6 &= \frac{s^2}{G_2(s)} \bullet I & V_6 &= \frac{s^2}{G_2(s)} \bullet V \end{aligned}$$

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9. An estimating apparatus for a secondary cell as claimed in claim 8, wherein the open-circuit voltage (Vo(k)) at the time point of k is estimated from the following equation:

$$\frac{(T_1 \bullet s+1)}{G_2(s)} \bullet V_0 = \frac{1}{G_2(s)}(a \bullet s^2 + b \bullet s + 1) \bullet V - \frac{1}{G_2(s)}(c \bullet s^2 + d \bullet s + K) \bullet I \ .$$

10. An estimating apparatus for a secondary cell as claimed in claim 9, wherein the parameter estimating section integrally estimates the parameters used in the equation (1) at one time as follows:

$$\theta = \begin{bmatrix} -a \\ -b \\ c \\ d \\ e \\ f \end{bmatrix}$$

wherein f = h and h denotes a variable efficiency derived from the following equation: Vo = $\frac{h}{s} \bullet I$.

11. An estimating apparatus for a secondary cell as claimed in claim 10, wherein the equation (1) is arranged in an equivalent circuit model expressed as:

$$V = \frac{K \bullet (T_2 \bullet s + 1)}{T_1 \bullet s + 1} \bullet I + \frac{1}{T_3 \bullet s + 1} \bullet V_o \ .$$

12. An estimating apparatus for a secondary cell as claimed in claim 1, wherein the adaptive digital filter uses the cell model described in the equation (2) and the parameter estimating section integrally estimates all parameters (θ) in the equation (2) at one time.

13. An estimating apparatus for a secondary cell as claimed in claim 12, wherein, in a case where the terminal voltage of the secondary cell immediately

before the secondary cell becomes a predetermined excessive charge is assumed to be a maximum enabling voltage (V_{max}) and the terminal voltage of the secondary cell immediately before the secondary cell becomes a predetermined excessive discharge is assumed to be a minimum enabling voltage (V_{min}), the input enabling power estimating section estimates the input enabling power (P_{in}) of the secondary cell on the basis of the parameter estimated values (θ) and the open-circuit voltage (Vo), and the maximum enabling voltage (V_{max}) and the output enabling power estimating section estimates the output enabling power (P_{out}) of the secondary cell on the basis of the parameter estimated values (θ), the open-circuit voltage (Vo), and the minimum enabling voltage (V_{min}).

14. An estimating apparatus for a secondary cell as claimed in claim 13, wherein the input enabling power estimating section estimates the input enabling power (P_{in}) using the following equation:

$$\left.\begin{aligned} P_{in} &= I_{in\_\max} \bullet V_{\max} \\ &= \frac{V_{\max} - Vo}{K} \bullet V_{\max} \end{aligned}\right]$$

, wherein I_{in_max} denotes a maximum input current calculated from an equation: V = K • I + Vo, wherein V_{max} is substituted for V and K denotes an internal resistance of the secondary cell which corresponds to one of the parameter estimated values (θ), and I_{in_max} is substituted for I.

15. An estimating apparatus for a secondary cell as claimed in claim 14, wherein the output enabling

power estimating section estimates the output enabling power (P_{out}) as follows:

$$\left.\begin{aligned} P_{out} &= |I_{out\_max}| \bullet V_{min} \\ &= \frac{Vo - V_{min}}{K} \bullet V_{min} \end{aligned}\right]$$

, wherein I_{out_max} is a maximum output current calculated from an equation: $V = K \bullet I + Vo$ in which V_{min} is substituted for V and I_{out_max} is substituted for I.

16. An estimating apparatus for a secondary cell as claimed in claim 15, wherein the open-circuit voltage calculating section calculates the open-circuit voltage estimated value ($V_0(k)$) at a time point of k as follows: $V_0(k) = \Delta V_0(k) + V\_{ini}$, wherein V_{ini} denotes an initial value of the terminal voltage when no current is caused to flow into the secondary cell and $\Delta V_0(k) = \Delta V_0 = G_{1p}(s) \bullet V_0 = V_1 + T_1 \bullet V_2 - K \bullet T_2 \bullet I_2 - K \bullet I_1$, wherein

$$\left.\begin{aligned} G_{1p}(s) = \frac{1}{(p \bullet s + 1)^3}, \quad V_2 &= s \bullet G_{lp}(s) \bullet V, \quad V_1 = G_{lp}(s) \bullet V \\ I_2 &= s \bullet G_{lp}(s) \bullet I, \quad I_1 = G_{lp}(s) \bullet I \end{aligned}\right]$$

, wherein $G_{1p}(s)$ denotes a low pass filter, p denotes a constant determining a response characteristic of $G_{1p}(s)$, and T_1 and T_2 denote time constants of an equivalent circuit model of the secondary cell expressed in the equation (2).

17. An estimating apparatus for a secondary cell as claimed in claim 16, wherein the parameter estimating section integrally estimates all parameters used in the equation (2) at one time as follows:

$$\theta = \begin{bmatrix} -T_1 \\ K \bullet T_2 \\ K \\ h \end{bmatrix}$$

, wherein h denotes a variable efficiency and is derived from the following equation: $V_0 = \frac{h}{s} \bullet I$.

18. An estimating apparatus for a secondary cell as claimed in claim 16, wherein, in the equation (2), when $(T_1 \bullet s + 1)$ is substituted for A(s) and $K \bullet (T_2 \bullet S + 1)$ is substituted for B(s), the following equation is established:

$$V = \frac{K \bullet (T_2 \bullet s + 1)}{T_1 \bullet s + 1} \bullet I + \frac{1}{T_1 \bullet s + 1} \bullet V_o .$$

19. An estimating apparatus for a secondary cell, comprising:

current detecting means for detecting a current (I) charged into and discharged from the secondary cell;

voltage detecting means for detecting a terminal voltage (V) across the secondary cell;

parameter estimating means for integrally estimating all parameters (θ) at one time in at least one of the following equations (1) and (2) with the measured current (I) and terminal voltage (V) inputted into an adaptive digital filter using a cell model described in a corresponding one of the following equations (1) and (2) whose parameters are estimated;

open-circuit voltage calculating means for calculating an open-circuit voltage (Vo) using the

current (I), the terminal voltage (V), and the parameter estimated values (θ);

input enabling power estimating means for estimating an input enabling power (P_{in}) of the secondary cell on the basis of the parameter estimated values (θ) and open-circuit voltage (Vo); and

output power enabling power estimating means for estimating an output enabling power (P_{out}) of the secondary cell on the basis of the parameter estimated values and the open-circuit voltage (Vo), the equation (1) being

$$V = \frac{B(s)}{A(s)} \bullet I + \frac{1}{C(s)} \bullet Vo \quad \ldots (1),$$ wherein

$A(s) = \sum_{k=0}^{n} a_k \bullet s^k$, $B(s) = \sum_{k=0}^{n} b_k \bullet s^k$, $C(s) = \sum_{k=0}^{n} c_k \bullet s^k$, s denotes a Laplace transform operator, A(s), B(s), and C(s) denote each poly-nominal of s (n denotes degrees), $a_1 \neq 0$, $b_1 \neq 0$, and $c_1 \neq 0$ and the equation (2) being $V = \frac{B(s)}{A(s)} \bullet I + \frac{1}{A(s)} \bullet Vo$ ... (2), wherein

$A(s) = \sum_{k=0}^{n} a_k \bullet s^k$ and $B(s) = \sum_{k=0}^{n} b_k \bullet s^k$.

20. An estimating method for a secondary cell, comprising:

detecting a current (I) charged into and discharged from the secondary cell;

detecting a terminal voltage (V) across the secondary cell;

integrally estimating all parameters (θ) at one time in at least one of the following equations (1)

and (2) with the measured current (I) and terminal voltage (V) inputted into an adaptive digital filter using a cell model described in a corresponding one of the following equations (1) and (2) whose parameters are estimated;

calculating an open-circuit voltage (Vo) using the current (I), the terminal voltage (V), and the parameter estimated values (θ);

estimating an input enabling power (P_{in}) of the secondary cell on the basis of the parameter estimated values (θ) and open-circuit voltage (Vo); and

estimating an output enabling power (P_{out}) of the secondary cell on the basis of the parameter estimated values and the open-circuit voltage (Vo), the equation (1) being

$$V = \frac{B(s)}{A(s)} \bullet I + \frac{1}{C(s)} \bullet Vo \quad \ldots (1),$$ wherein

$A(s) = \sum_{k=0}^{n} a_k \bullet s^k$, $B(s) = \sum_{k=0}^{n} b_k \bullet s^k$, $C(s) = \sum_{k=0}^{n} c_k \bullet s^k$, s denotes a Laplace transform operator, A(s), B(s), and C(s) denote each poly-nominal of s (n denotes degrees), $a_1 \neq 0$, $b_1 \neq 0$, and $c_1 \neq 0$ and the equation (2) being $V = \frac{B(s)}{A(s)} \bullet I + \frac{1}{A(s)} \bullet Vo$ ... (2), wherein

$A(s) = \sum_{k=0}^{n} a_k \bullet s^k$ and $B(s) = \sum_{k=0}^{n} b_k \bullet s^k$.